

CLAIMS

We Claim:

- 5 1) An etching solution for chemical mechanical planarization of a Cu/Ta/TaN surface comprising:
- a) an oxidizing reactant selected from the group consisting of  $H_2O_2$ ,  $HNO_3$  and mixtures thereof; and,
- b) a co-reactant is selected from the group consisting of  $H_3PO_4$ ,  $H_2SO_4$ ,  
 10  $HNO_3$ , oxalic acid, acetic acid, organic acids and mixtures thereof; and,
- c) other additives selected from the group consisting of selected from the group consisting of HCl, aliphatic alcohols, butylated hydroxytoluene, Agidol-2, 2,6-di-tert-butyl-4[(dimethylamino)methyl]phenol, 2,6-di-tert-4N,N-dimethylaminomethylphenol, borax, ethylene glycol,  $ZnSO_4$ , methanol, propanol,  
 15 poly(oxyethylene)lauryl ether, malic acid,  $HOOC(CX_2)_nCOOH$  wherein  $X=OH$ , amine, H and  $n=1-4$ ), 3% tartaric acid, 1% ethylene glycol, 1,2,4-triazole, 1,2,3-triazole, tetrazole, nonionic surfactant, ethanol, trifluoroethanol,  $SiF_6$ , organic salt surfactant, polyvinyl alcohol, diphenylsulfamic acid, sodium oxalate, benzotriazole, sodium lignosulfonate, glycol, gelatin carboxymethylcellulose,  
 20 amines, heavy metal salts, salts of Cu and Ta, KCl,  $CuCl_2$ ,  $SnCl_2$ , propylene glycol, 2-ethyl-hexylamine, copper carbonate, low molecular weight alcohols, glycols, phenols, aliphatic alcohols, polyvinylalcohols, anionic surfactants, cationic surfactants, fluorocarbon-based surfactants, nonionic surfactants having the properties of preferentially adhering to certain materials, modifying thereby the  
 25 chemical reactivity where so adhered, polyvinyl alcohol solution stabalizers and species inhibiting spontaneous decomposition of oxidizing agents, wetting agents and mixtures thereof.
- 2) An etching solution as in claim 1 further comprising a species selected from  
 30 the group consisting of  $CuCl$ ,  $FeCl$ ,  $FeCl_3$ , and mixtures thereof.

- 3) An etching solution for chemical mechanical planarization of a Cu/Ta/TaN surface comprising species selected from the group consisting of  $\text{NaClO}_3$ ,  $\text{FeNO}_3$ ,  $(\text{NH}_4)_2\text{S}_2\text{O}_8$ ,  $\text{CuNH}_4\text{Cl}_3$ ,  $\text{Na}_2\text{S}_2\text{O}_8$ ,  $\text{K}_2\text{S}_2\text{O}_5$ ,  $\text{NH}_4\text{F}$ ,  $\text{CuSO}_4$ ,  $\text{NH}_4\text{OH}$ , sodium EDTA salt of wetting agent and mixtures thereof.
- 4) An etching solution for chemical mechanical planarization of a Cu/Ta/TaN surface comprising species selected from the group consisting of,  $(\text{NH}_4)_2\text{S}_2\text{O}_8$ ,  $\text{KOH}$ ,  $\text{NH}_4\text{OH}$ ,  $\text{H}_2\text{O}_2$ ,  $\text{Cu}(\text{NO}_3)_2$  and mixtures thereof.
- 5) An etching solution for chemical mechanical planarization of a Cu/Ta/TaN surface comprising species selected from the group consisting of  $\text{HF}$ ,  $\text{HNO}_3$ ,  $\text{H}_2\text{O}_2$ ,  $\text{H}_2\text{SO}_4$ , lactic acid and mixtures thereof.
- 6) An etching solution for chemical mechanical planarization of a Cu/Ta/TaN surface comprising species selected from the group consisting of,  $\text{NaOH}$ ,  $\text{KOH}$ ,  $\text{NH}_4\text{OH}$ ,  $\text{H}_2\text{O}_2$ , and mixtures thereof.
- 7) An etching solution for chemical mechanical planarization of a Cu/Ta/TaN surface comprising: EDTA,  $\text{NH}_4\text{OH}$ ,  $\text{H}_2\text{O}_2$ , in aqueous solution.
- 8) An etching solution for chemical mechanical planarization of a Cu/Ta/TaN surface comprising: citric acid, erythorbic acid, triethanolamine, in aqueous solution.
- 9) An etching solution for chemical mechanical planarization of a Cu/Ta/TaN surface comprising: trisodium citrate, triethanolamine, sodium nitrate, in aqueous solution.

10) An etching solution for chemical mechanical planarization of a Cu/Ta/TaN surface comprising:  $H_2SO_4$ ,  $H_2O_2$ , sodium molybdate, phenolsulfonic acid, in aqueous solution.

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5 11) An etching solution for chemical mechanical planarization of a Cu/Ta/TaN surface comprising: mineral acid, molybdenum salt.

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10 12) An etching solution for chemical mechanical planarization of a Cu/Ta/TaN surface as in claim 1 further comprising abrasive particles selected from the group consisting  $SiO_2$ ,  $Al_2O_3$  metallic and solid elemental particles, polymer particles, oxides, carbides, fluorides, carbonates, borides, nitrides, hydroxides of Al, Ag, Au, Ca, Ce, Cr, Cu, Fe, Gd, Ge, La, Ir, Hf, Mn, Mg, Ni, Nd, Pb, Pt, P, Sb, Sc, Sn, Tb, Ti, Ta, Th, Y, W, Zn, Zr, and mixtures thereof.

15 13) An etching solution as in claim 12 wherein said abrasive particles are coated.

14) An etching solution as in claim 13 wherein said coating is a chemically active species.

20 15) An etching solution as in claim 12 wherein said coating is  $CeO_2$ .

16) An etching solution as in claim 12 wherein said particles are produced by the sol method.

25 17) An etching solution as in claim 12 wherein said particles have a range of sizes from approximately 4 nanometers to approximately 5 micrometers.

18) An etching solution as in claim 12 wherein said particles have a size less than approximately 5 micrometers.

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